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REMARKS

Claims 1-20 are pending.

The rejection of claims 1-4, 6-9 and 19 under 35 U.S.C. 103(a) as being unpatentable over Koiwa is respectfully traversed.

Claim 1 recites a circuit for controlling an ignition coil. A coil driver is in communication with the ignition coil. A first node receives a coil control signal. A second node is connected to the coil driver. A capacitor is in communication with the second node to gradually increase a voltage at the second node to energize the ignition coil. A first diode includes a cathode in communication with the first node and an anode in communication with the capacitor for providing a discharge path to discharge the capacitor after the ignition coil has been energized.

The voltage stored by the capacitor, in the present invention, is used as a control voltage to turn on and off the coil driver and is not provided to directly to the ignition coil; rather, it is used to gradually energize the coil driver. As the capacitor is charged, it gradually increases the voltage supplied to the coil driver until the voltage reaches a predetermined level which turns on the coil driver. The coil driver, when activated, energizes the ignition coil with a voltage other than the voltage supplied by the capacitor (i.e., vehicle battery voltage of 12 volts). As a result, the turn-on circuit shown is only used to control the coil driver which selectively provides power to the ignition coil from a voltage source other than the capacitor.

Koiwa describes an ignition apparatus for an internal combustion engine. The apparatus uses a power source connected to a DC to DC converter or amplifier which converts or amplifies the output voltage to several hundred volts. In contrast to the present invention, in Koiwa, the power provided to the capacitor is the voltage used to excite the ignition coil, whereas the voltage supplied by the capacitor to the coil driver of the present invention is only used to turn on the coil driver, not power the coil. In Koiwa,

PAGE 2/7 * RCVD AT 12/12/2006 3:54:30 PM [Eastern Standard Time] * SVR:USPTO-EFXRF-5/20 * DNIS:2738300 * CSID:7345429569 * DURATION (mm-ss):06-26

the high voltage used to energize the ignition coil increases radio interference in addition to increasing the feed forward voltage.

The operation of the control circuit of the present invention is described as follows. During the initial charge of the capacitor, the voltage at the coil driver output node increases rapidly to a level just below where the coil driver begins to turn on (see 32 in Fig. 2). The resistance by the diode in cooperation with the resistor allows the capacitor to charge gradually over a charging period (see 34 in Fig. 2). That is, the rate of the increased voltage is controlled by the selection of the resistor and the capacitor. When the predetermined voltage level is reached, the coil driver 18 is turned on to fire the coil. The slowing of the initial turn-on of the coil driver 18 has an affect of attenuating the feed forward voltage. This attenuation of the feed forward voltage minimizes degradation of the spark gap while alleviating the need for a high voltage zener diode. The zener diode as shown in Fig. 1 also provides a path for quickly discharging the capacitor so that the coil driver may be quickly coupled to ground for rapidly collapsing the coil. An advantage of this turn-on circuit allows for the use of smaller spark plug gap. The smaller gap and elimination of a high voltage zener diode improves signal strength and signal-to-noise ratio of an ionization misfire detection system.

Moreover, the circuit architecture of Koiwa is entirely different than the circuit architecture recited in claim 1. In Koiwa, a rectifying diode 3 has an anode coupled to the output of the converter 2 and a cathode coupled to an end of the capacitor 4 (note claim 1 recites the anode of the diode is in communication with the capacitor). The other end of the capacitor 4 is connected to ignition coil 5. A trigger circuit 8 is connected to the battery 1 and the signal generator 7 for generating an ignition signal. A switching element 9 in the form of a thyristor has its anode connected to a node P1 between the rectifying diode 3 the capacitor 4, and its cathode connected to the node (unlabeled) between primary winding of the ignition coil 5 and ground. The switching element 9 includes a control gate connected to an output terminal of the trigger circuit 8 so it is switched on by a trigger signal

from the trigger circuit to allow the capacitor 4 to discharge by way of the primary winding in ignition coil 5. That is, when the switching element 9 is turned on by the trigger signal produced by the ignition signal generator at any predetermined crankshaft position for ignition timing, the charged capacitor 4 discharges by the path of the capacitor 4; a switching element 9, and the primary winding of the ignition coil 5. High-voltage developed across the secondary winding of the ignition coil 5 causes the spark plug to generate a spark. As a result, the high voltage generated by the circuit shown in Koiwa is provided directly to the coil. The turn-on circuit of the present invention is utilized to gradually turn on a coil driver, which in turn, provides voltage to the coil from a voltage source other than the voltage supplied to the coil driver by the turn-on circuit. In addition, the voltage is not a high voltage supplied to the turn-on circuit.

The fact that Koiwa is an ignition apparatus and utilizes a diode and capacitor in its circuitry without reciting the specific recited electrical architecture does not render claim 1 obvious. The specific positioning of the diode with respect to other electrical components in addition to the turn-on circuit being used to turn on and off the coil driver is neither shown nor suggested by Koiwa, nor is it obvious to one skilled in the art. The Office action has not provided any references that teach or suggest the electrical architecture as recited in claim 1. Such a circuit design is neither a minor design variation nor is it obvious.

The Office action further states that the claim language fails to indicate advantages compared to the know primary objective of automotive ignition systems. It is pointed out that the claims do not need to recite advantages for illustrating novelty. One of ordinary skill in the art can ascertain the advantages of such a electrical design. Furthermore, the advantages which the invention provides is set forth in the instant application which describes in detail that the slowing of the initial turn-on of the coil driver has an affect of attenuating the feed forward voltage. This attenuation of the feed forward voltage minimizes degradation of the spark gap while alleviating the need for a

high voltage zener diode. The non-high voltage zener diode, as shown in Fig. 1, also provides for a path for quickly discharging the capacitor so that the coil driver may rapidly collapse the field of the coil. In addition, the turn-on circuit allows for the use of a smaller spark plug gap. The smaller gap and the elimination of a high voltage zener diode improves signal strength and signal-to-noise ratio of an ionization misfire detection system. (Par. [0009-0011].

Claim 2 recites a first resistor in communication with the capacitor for controlling a charging time period of the capacitor. The resistor 24 is connected between the cathode of the zener diode 26 and the coil driver output node 14. The resistance of the diode in cooperation with the resistor allows the capacitor, to charge gradually over a charging period (Par. [0020]-[0021]).

Koiwa fails to teach or suggest a resistor. The charging time of the capacitor is controlled by the trigger off time of the triggering circuit. That is while the triggering circuit is off, the capacitor charges. In addition, a very high voltage is supplied directly to capacitor. The present invention utilizes the diode and resistor to gradually charge the capacitor. A "high voltage" zener diode is not required which may otherwise result in early ignition and degradation issues of the spark gap which can lead to engine roughness, higher emissions, and increased fuel consumption, as well as radio interference. Since Koiwa fails to teach or suggest a resistor, claim 2 is allowable.

Claim 3 recites a second resistor in communication with the resistor for controlling a discharging time period of the capacitor. Koiwa fails to teach or suggest a second resistor or a first resistor. Therefore, claim 3 is allowable.

Claim 4 recites the charging time period is greater than the discharging time period. Koiwa fails to teach the charging time period greater than the discharging time period. Therefore, claim 4 is allowable.

Claims 6 recites the first resistor and capacitor are in communication with an electrical ground. Koiwa fails to teach or

suggest a first resistor. Therefore, claim 6 is allowable.

Claim 7 recites that the first diode is a low voltage zener diode. Koiwa fails to teach or suggest the diode is a low voltage zener diode let alone a zener diode. The zener diode allows for forward current flow for charging the capacitor and reverse current flow for discharging the capacitor. Therefore, claim 7 is allowable.

Claim 8 recites the anode of the first diode is connected to the first resistor and the capacitor. The cathode of diode 3 in Koiwa is connected to the capacitor, not the anode. In addition, Koiwa does not describe or show a resistor connected to the first diode 3. Therefore claim 8 is allowable.

Claim 9 recites the first resistor, the capacitor, and the anode of the first diode are connected to the second node. As discussed earlier, Koiwa does not show a resistor, nor is the anode of the first diode connected to the second node, nor is the capacitor connected to the second node. Therefore claim 9 is allowable.

Claim 19 recites a method for controlling an ignition coil. The voltage is increased to the ignition coil quickly to a level just below the coil firing voltage. The voltage to the ignition coil is increased during an ignition period to reduce the feed forward voltage. The voltage is discharged to the ignition coil quickly after the ignition period.

Koiwa, as described earlier charges the capacitor under high load. The triggering circuit turns on the switching element and the capacitor is coupled to ground thereby discharging the capacitor through the primary coil for igniting the spark plug. Koiwa does not teach or suggest increasing the voltage to the ignition coil during an ignition period just below the coil firing voltage. Koiwa does not teach or suggest increasing the voltage to the ignition coil during an ignition period to reduce the feed forward voltage of the diode. Koiwa fails to teach or suggest the method as recited in claim 19. Therefore, claim 19 is allowable.

In view of the foregoing amendment and remarks, all pending claims are in condition for allowance. Favorable action is respectfully solicited.

Respectfully submitted,

Date: 12/12/2006

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